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Forest Insect & Disease Management
Pacific Northwest Region

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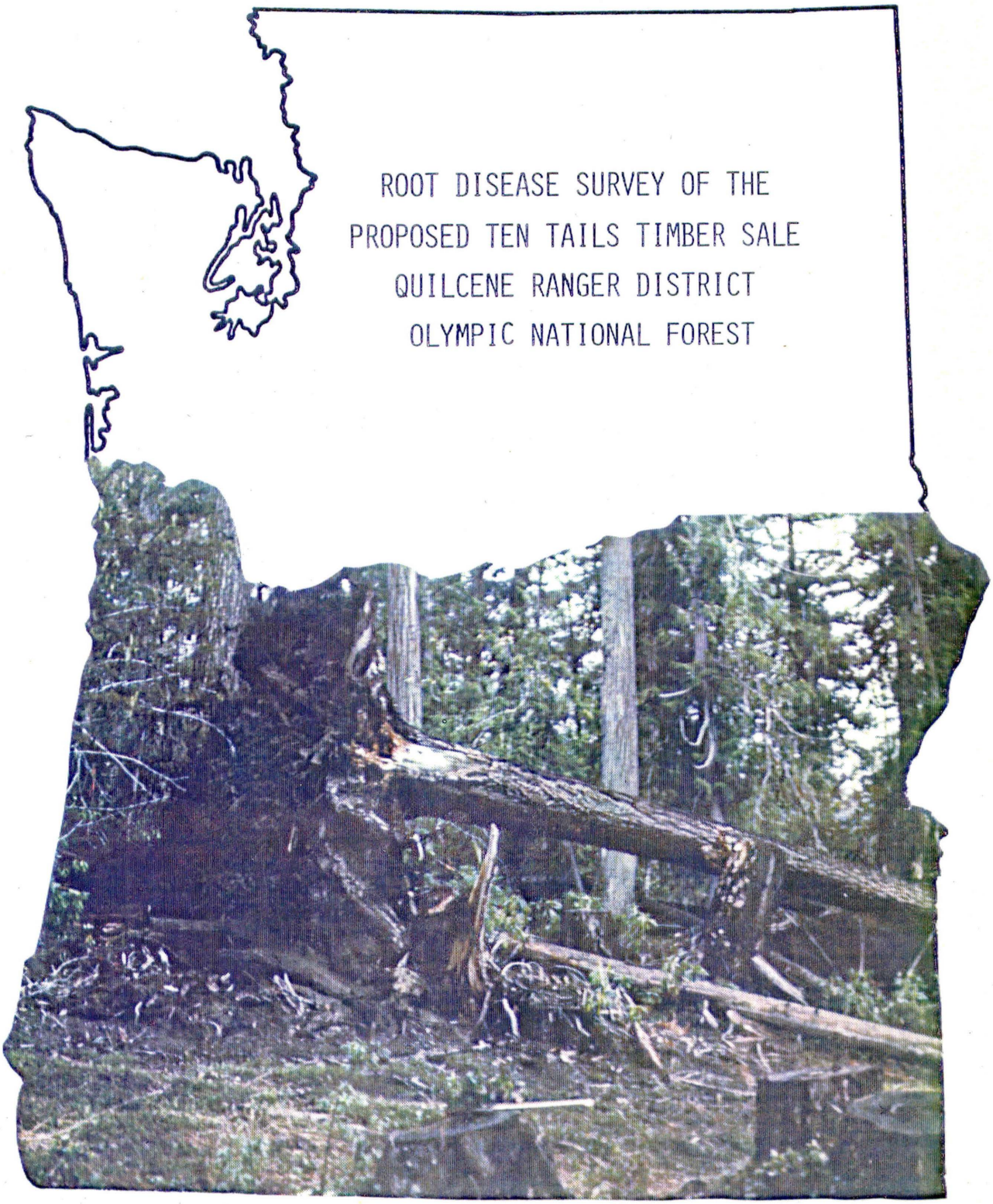

ROOT DISEASE SURVEY OF THE PROPOSED TEN TAILS TIMBER SALE QUILCENE RANGER DISTRICT OLYMPIC NATIONAL FOREST

ROOT DISEASE SURVEY OF THE PROPOSED TEN TAILS TIMBER SALE, QUILCENE RANGER DISTRICT, OLYMPIC NATIONAL FOREST

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INTRODUCTION

During the weeks of October 15-26, 1979, a root disease survey was done on the proposed Ten Tails Timber Sale, Quilcene Ranger District, Olympic National Forest, T. 29 N., R. 3 W., Sec. 28, 29, 32, and 33 (Figure 1) by a Forest Insect and Disease Management pathology crew. District personnel had previously noticed laminated root rot (caused by *Phellinus (Poria) weirii*) in the stand and requested an evaluation to determine its extent and severity and to help in developing silviculture prescriptions for the area.

METHODS

The survey was done using a systematic, variable plot method. Plots were located on a 2-by-5 chain grid across the stand (Figure 2). A 20-factor prism was used at each plot center. All trees in each prism plot were examined and the following information recorded: tree species, DBH, and general condition (live, dead, standing, down). In addition, two roots on opposite sides of each tree were excavated to a distance of 3 feet and examined for evidence of root disease. From the data collected in each prism plot, mean basal area, number of trees, and volume per acre were calculated by tree species, DBH class, and disease condition. A .01-acre fixed-area plot also was established at each plot center for the purpose of assessing disease severity in trees too small to be measured on the prism plot. All trees greater than 6 inches tall and less than 5 inches DBH in the fixed-area plots were tallied and examined for disease.

RESULTS AND DISCUSSION

The stand examined was composed primarily of 40- to 80-year-old Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), Alaska yellow cedar (*Chamaecyparis nootkatensis*), and grand fir (*Abies grandis*). A few old-growth trees were scattered through the stand. Judging by the number of stumps found in parts of the stand, some selective harvest or perhaps salvage logging had been done in the past. Portions of the stand also exhibited evidence of wildfire.

Root diseases were found distributed across the entire area surveyed (Figure 2 overlays). There did not appear to be any distinctive pattern in the distribution of the diseases across the sale area. Two-hundred-seven of 318 plots (65 percent) had at least one root-diseased tree. Mean per acre basal area, tree numbers, and volume for healthy and diseased trees are shown in Tables 1, 2, and 3. Overall, 15 percent of the trees in all basal area plots containing 8.5 percent of the volume had detectable root diseases. In addition, 9.1 percent of the small trees in fixed area plots and 33.7 percent of all stumps examined showed evidence of infection by root disease fungi.

By far the most commonly encountered disease was laminated root rot. This disease was identified by the typical laminated decay that separates readily at the annual rings, the reddish, whiskery setal hyphae found between the sheets of rotted wood, and the grayish ectotrophic mycelium (mycelium on root surfaces) of the causal fungus. Laminated root rot was affecting 76 percent of

all diseased trees in basal area plots, 75 percent of all small diseased trees on fixed-area plots, and 58 percent of all stumps that showed evidence of disease. Distribution was as shown in Figure 3. Douglas-fir, western hemlock, and grand fir were hosts of the disease with most damage occurring in the first-mentioned species.

Laminated root rot is a particularly dangerous disease because the causal pathogen is persistent on the site. It can survive for long time periods (up to 50 years) in large roots of old stumps, infecting via root contacts new hosts that become established on the site. Infection centers increase in size due to subsequent spread of the causal fungus from tree to tree along roots.

Recommended control for laminated root rot is to cut all susceptible hosts in infection centers and a 50-foot buffer around each and (1) mechanically remove stumps and roots and replant with susceptible species or (2) leave stumps but replant with immune, resistant, or tolerant tree species. Tree species occurring in the survey area ranked by degree of susceptibility to laminated root rot are: highly susceptible--Douglas-fir, grand fir; intermediate--western hemlock, spruce; tolerant--western white pine, resistant cedars; immune--all hardwoods.

Shoestring root rot caused by *Armillaria mellea* also was encountered in the area examined. Shoestring root rot was identified by the thick, white mycelial fans formed under bark of roots and butts, dark shoestring-like infective structures called rhizomorphs, and the stringy, wet rot marked with numerous zone lines. This disease was involved in 20 percent of diseased basal area plot trees, 21 percent of small diseased trees in fixed-area plots, and 32 percent of stumps with evidence of disease. Distribution was as shown in Figure 2. Douglas-fir, western hemlock, and rarely, cedars were affected. Shoestring root rot frequently occurred in the same infection centers as laminated root rot. *Armillaria mellea* commonly invades trees previously infected by *P. weirii*.

Armillaria mellea also survives in old stumps and roots and infects nearby trees across root contacts or by growing short distances through the soil. It is, however, a less aggressive pathogen than *P. weirii*. It generally affects stressed or injured trees, including trees weakened by other pathogens. Recommended control for shoestring root rot is "to develop and maintain a vigorous stand."

One other root pathogen, *Fomes annosus*, (cause of annosus root and butt rot) was observed occasionally sporulating in hollowed western hemlock stumps. This pathogen can be damaging in old-growth western hemlock, but in stands managed on a rotation of 120 years or less, it does not pose much danger.

MANAGEMENT RECOMMENDATIONS

Root diseases, mainly laminated root rot, are widely distributed and cause light to moderate damage across the entire Ten Tails Unit. The following management alternatives are offered:

(1) Do not manage specifically for the root diseases. Following harvest, replant the area with Douglas-fir and manage the developing stand with normal entries and rotation. If this option is chosen, we would expect levels of disease-caused loss to be at least as great in the next stand as in that currently on the site. Potentially, they might be much greater, perhaps as much as 40 percent of the future volume. If this alternative is followed, volume projections should be revised downward.

(2) Following harvest, replant the unit with Douglas-fir, but modify subsequent management activity. Monitor the stand closely, and keep records of where root rot damage develops. Do not precommercially thin the stand or restrict precommercial thinning to the few areas where there is no *P. weirii* inoculum. As trees reach pole size, consider salvage entries. Remove dead and dying trees. Also, remove trees around root rot infection pockets as follows: (a) if stand can be entered at 5-year intervals, remove only trees exhibiting symptoms, (b) if stand entries are limited to 6-10 year intervals, remove all susceptible trees within 25 feet of infection centers, (c) if stand entries are limited to greater than 10-year intervals, remove all susceptible trees within 40 feet of infection centers. Manage for a short rotation (80 years or less) for the entire unit, especially if monitoring shows that disease losses are increasing with stand age. Finally, if disease losses are significantly greater at the end of the rotation, consider a more intensive disease management program at the beginning of the following rotation as in (3) or (4) below.

(3) Following harvest, mechanically remove stumps in and within 50 feet of all laminated root rot infection centers or harvest by pushing over trees. Physically remove all inoculum sources by pushing or pulling stumps (old and new) out of the ground with heavy equipment. Replant with Douglas-fir and other species adapted to the site. This treatment will effectively control *P. weirii* and any associated *A. mellea*. Unfortunately, it would be expensive (costs of $250 to $450 per acre have been reported) and very difficult on the steeper terrain. It also might cause soil compaction, erosion, or other soil problems on sites with critical soils.

(4) Following harvest, change tree species in and within 50 feet of areas that are now laminated root rot centers. Replant with immune, resistant, tolerant or intermediate tree species. If immune species (hardwoods) are grown for a rotation (50 years), *P. weirii* should die out over most of the area and Douglas-fir could be grown in the following rotation with almost no likelihood of additional losses. Use of resistant conifers (cedars) should have much the same effect. If tolerant species (western white pine) are used, they should not suffer damage. However, they may rarely become infected and may maintain the disease. If Douglas-fir was planted in the following rotation, there would be some potential, though very much reduced, for renewed infection and damage. If intermediate species (western hemlock, spruce) are grown in the next rotation, they should suffer little damage. However, many will be infected and the disease will be maintained on the site. Planting with Douglas-fir in the following rotation would be dangerous.

Given the distribution of root disease and the levels of damage currently observed on the site, probably the best management strategy would combine alternatives 2 and 4. Intermediate or, preferably tolerant, resistant and/or

immune tree species could be planted in areas suitable for the species involved and especially in areas currently showing significant root disease damage. Douglas-fir could be grown in other portions of the area but would need to be closely monitored and treated as outlined in (2) if disease damage developed. Whatever management alternative(s) are chosen for the Unit, local seed source planting stock and quality planting techniques should be used when reforesting the stand. Use of vigorous stock well adapted to the site should reduce likelihood of *A. mellea* becoming damaging in the future.

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Table 1.--Mean basal area ft^2/acre for Ten Tails Unit.

DBH Class	Douglas-fir		Western Hemlock		Cedars		Grand Fir		All Species	
	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased
8	12.0	3.0	1.6	0.8	2.4	0.0	0.8	0.4	16.8	4.2
10	13.4	1.6	4.6	0.4	3.8	0.0	0.0	0.0	21.8	2.0
12	6.8	2.0	3.4	0.4	0.8	0.4	0.8	0.4	11.8	3.2
14	4.0	0.8	0.0	0.3	1.2	0.0	0.0	0.0	5.2	1.1
16	3.8	1.0	2.0	0.4	1.2	0.0	0.0	0.0	7.0	1.4
18	3.4	0.4	0.0	0.1	0.0	0.0	0.0	0.0	3.4	0.5
20	0.0	0.2	1.0	0.2	2.4	0.0	0.0	0.0	3.4	0.4
22	0.8	0.4	0.0	0.1	3.8	0.0	0.0	0.0	4.6	0.5
24	2.0	0.4	1.2	0.0	1.2	0.0	0.0	0.0	4.4	0.4
26	7.2	0.2	1.2	0.0	2.4	0.0	0.0	0.0	10.8	0.2
28	3.6	0.2	1.2	0.0	0.0	0.0	0.0	0.0	4.8	0.2
30	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	1.2	0.0
32	4.8	0.2	0.0	0.0	1.2	0.0	0.0	0.0	6.0	0.2
34	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0
36	1.2	0.0	0.0	0.0	1.2	0.0	0.0	0.0	2.4	0.0
38	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0
40	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0
42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	2.2	0.2	0.0	0.0	1.2	0.0	0.0	0.0	3.4	0.2
46	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0
52+	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	1.2	0.0
Total	73.8	10.6	17.4	2.7	24.0	0.4	1.6	0.8	116.8	14.5

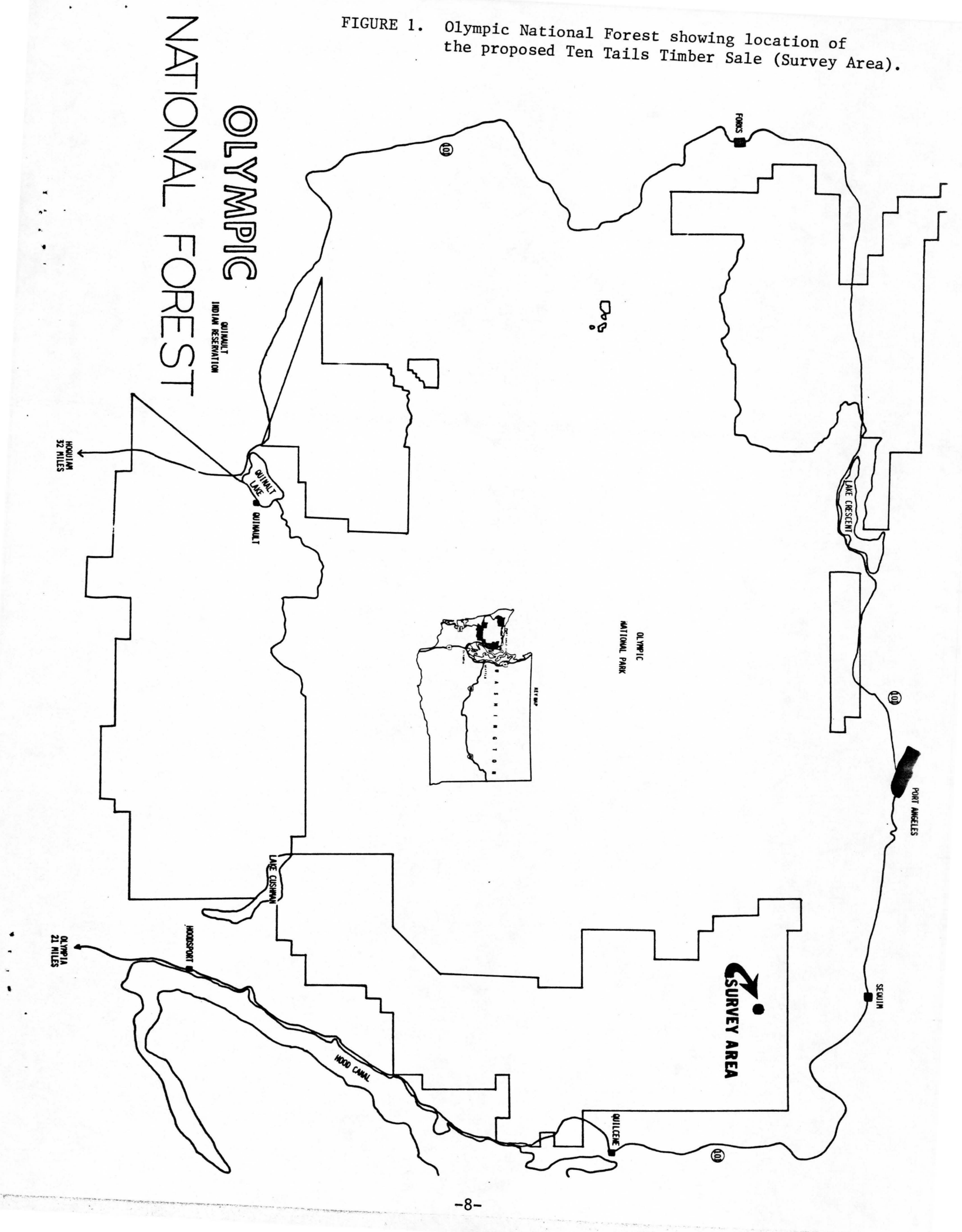
Table 2.--Mean number of trees per acre in Ten Tails Unit.

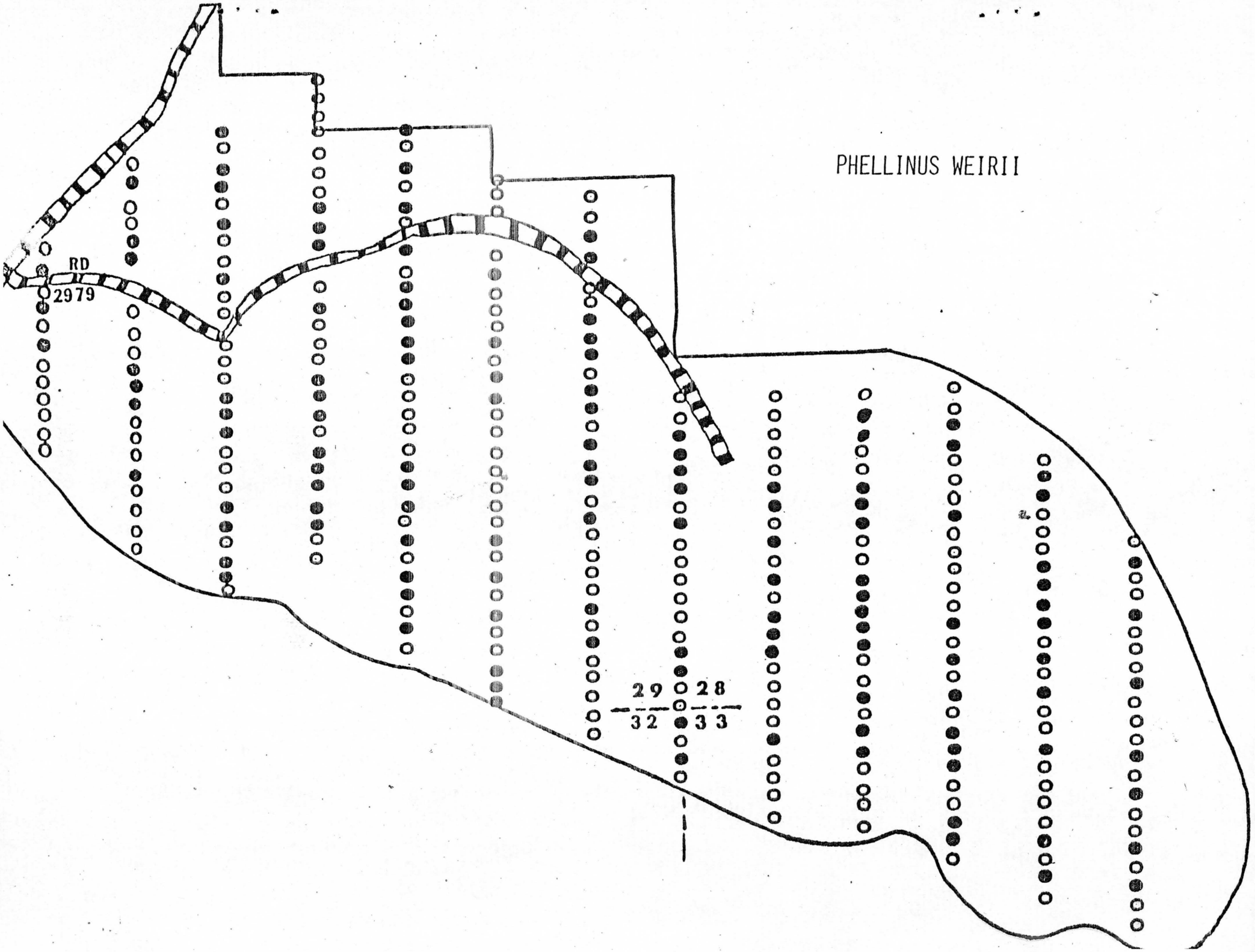
DBH Class	Douglas-fir		Western Hemlock		Cedars		Grand Fir		All Species	
	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased
8	34.73	8.24	4.82	2.06	6.88	0.00	2.29	1.14	48.72	11.44
10	24.56	2.94	8.01	0.66	6.97	0.00	0.00	0.00	39.54	3.60
12	8.70	2.50	4.24	0.60	1.03	0.50	1.02	0.50	14.99	4.10
14	3.81	0.68	0.00	0.56	1.12	0.00	0.00	0.00	4.93	1.24
16	2.76	0.68	1.38	0.34	0.86	0.00	0.00	0.00	5.00	1.02
18	1.87	0.28	0.00	0.07	0.00	0.00	0.00	0.00	1.87	0.35
20	0.00	0.20	0.49	0.06	1.10	0.00	0.00	0.00	1.59	0.26
22	0.37	0.08	0.00	0.02	1.43	0.00	0.00	0.00	1.80	0.10
24	0.64	0.12	0.38	0.00	0.38	0.00	0.00	0.00	1.40	0.12
26	1.94	0.06	0.32	0.00	0.65	0.00	0.00	0.00	2.91	0.06
28	0.87	0.02	0.28	0.00	0.00	0.00	0.00	0.00	1.15	0.20
30	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.24	0.00
32	0.85	0.04	0.00	0.00	0.21	0.00	0.00	0.00	1.06	0.04
34	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00
36	0.17	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.34	0.00
38	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.00
40	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00
42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
44	0.21	0.02	0.00	0.00	0.11	0.00	0.00	0.00	0.32	0.02
46	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00
48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00
52+	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.08	0.00
Total	82.48	15.86	20.16	4.37	20.99	0.50	3.31	1.64	126.94	22.37

Table 3.--Mean bd. ft. volume per acre for Ten Tails Unit.

DBH Class	Douglas-fir		Western Hemlock		Cedars		Grand Fir		All Species	
	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased
8	1285.0	304.8	178.3	76.2	275.2	0.0	84.7	42.2	1823.2	423.2
10	1105.2	132.2	851.0	66.0	418.2	0.0	0.0	0.0	2374.4	198.2
12	435.0	125.0	551.2	78.0	82.4	40.0	51.0	25.0	1119.6	268.0
14	491.4	87.8	0.0	49.0	112.0	0.0	0.0	0.0	603.4	136.8
16	648.6	159.8	303.6	74.8	116.1	0.0	0.0	0.0	1068.3	234.6
18	686.3	102.8	0.0	20.6	0.0	0.0	0.0	0.0	686.3	123.4
20	0.0	49.4	181.3	22.2	280.5	0.0	0.0	0.0	461.8	71.6
22	243.0	53.6	0.0	8.8	457.6	0.0	0.0	0.0	700.6	62.4
24	505.6	94.8	199.5	0.0	155.8	0.0	0.0	0.0	860.9	94.8
26	1883.8	58.2	224.0	0.0	318.5	0.0	0.0	0.0	2426.3	58.2
28	1057.8	49.2	232.4	0.0	0.0	0.0	0.0	0.0	1290.2	49.2
30	0.0	0.0	252.0	0.0	0.0	0.0	0.0	0.0	252.0	0.0
32	1428.0	67.2	0.0	0.0	201.6	0.0	0.0	0.0	1629.6	67.2
34	357.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	357.2	0.0
36	365.5	0.0	0.0	0.0	227.8	0.0	0.0	0.0	593.3	0.0
38	1152.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1152.0	0.0
40	371.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	371.1	0.0
42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	648.4	67.2	0.0	0.0	280.5	0.0	0.0	0.0	928.9	67.2
46	355.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	355.9	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	400.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	400.8	0.0
52+	0.0	0.0	0.0	0.0	375.2	0.0	0.0	0.0	375.2	0.0
Total	13420.6	1352.0	2973.3	395.6	3301.4	40.0	135.7	67.2	19831.0	1854.8

FIGURE 1. Olympic National Forest showing location of the proposed Ten Tails Timber Sale (Survey Area).

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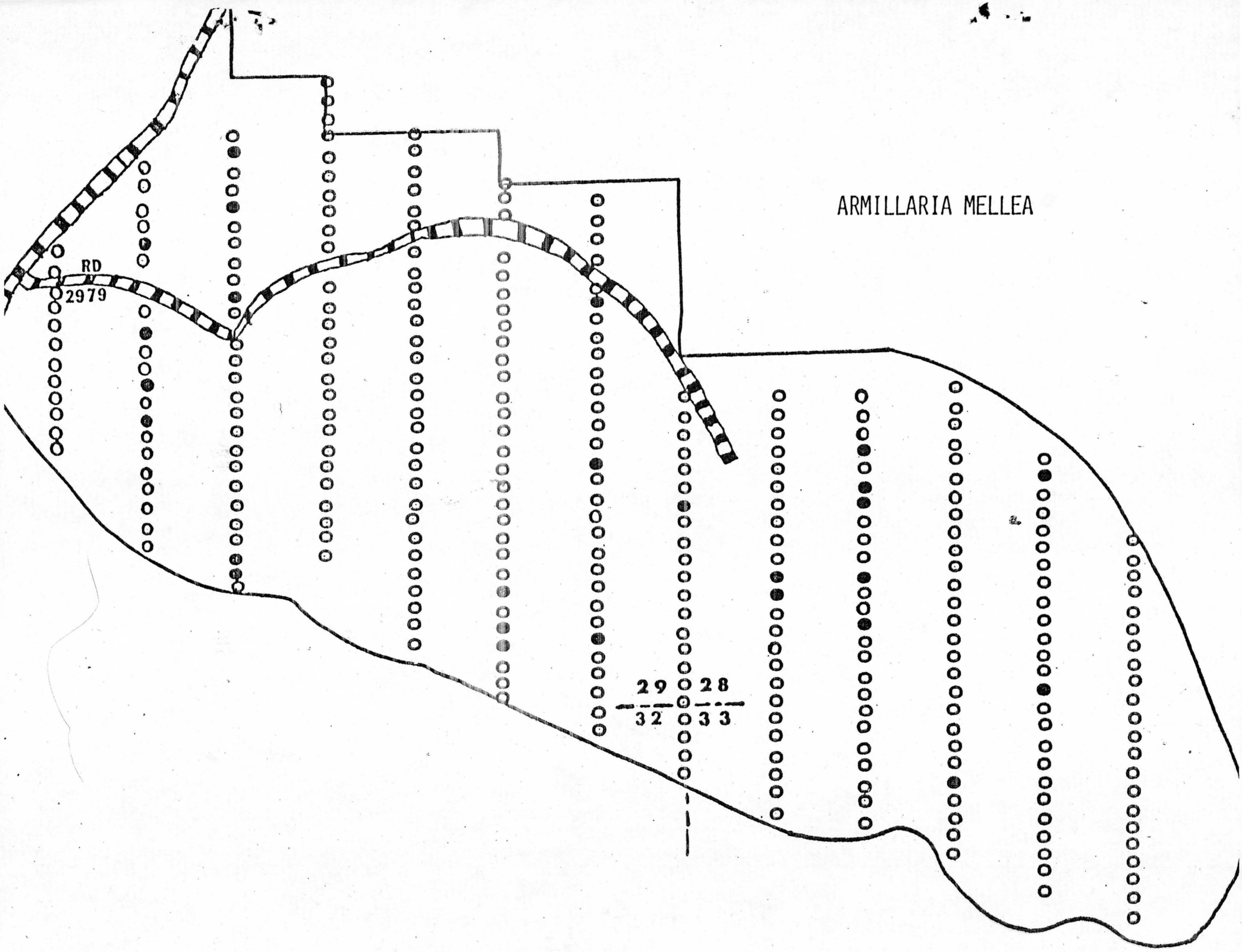
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